DOCUMENT RESUME

ED 076 639 TM 002 644

AUTHOR Carver, Donald W.; Liberty, Paul G.
TITLE A Comparison of Two Approaches in Factor Studies of Student Ratings of Courses and Instructors.
PUB DATE Feb 73
NOTE 19p.; Paper presented at American Educational Research Association Meeting (New Orleans, Louisiana, February 25-March 1, 1973)

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *Comparative Analysis; *Course Evaluation; *Factor Analysis; Rating Scales; *Student Opinion; *Teacher Evaluation; Technical Reports

ABSTRACT

Results of two factor analyses of 3,722 student ratings of engineering courses and instructors, obtained by using alternative step factoring criteria, were compared on the basis of six criteria. Results indicated that the ten factor solution obtained by using a step criterion of accounting for 70-75% of the total variance as opposed to a five factor solution containing only factors having an eigenvalue greater than 1.0 accounted for a higher percentage of the total variance, clarified factor structure, provided more useful information for administrative decision-making, and supported the view that a 1.0 eigenvalue step criterion is unnecessarily restrictive in certain situations. (Author)

FORM 8510
PRINTED IN U.S.A.

FILMED FROM BEST AVAILABLE COPY

ED 076639

U S DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY

A COMPARISON OF TWO APPROACHES IN FACTOR STUDIES OF STUDENT RATINGS OF COURSES AND INSTRUCTORS

Donald W. Carver and Paul G. Liberty

TM 002 044

Paper Presented at the Annual Meeting of The American Educational Research Association

New Orleans, Louisana

February 1973

ABSTRACT

A Comparison of Two Approaches in Factor Studies of Students Ratings of Courses and Instructors

Donald W. Carver, Measurement and Evaluation Center, The University of Texas at Austin
Paul G. Liberty, Jr., Measurement and Evaluation The University of Texas at Austin

Results of two factor analyses of 3772 student ratings of engineering courses and instructors, obtained by using alternative step factoring criteria, were compared on the basis of six criteria. Results indicated that the ten factor solution obtained by using a step criterion of accounting for 70 - 75% of the total variance as opposed to a five factor solution containing only factors having an eigenvalue greater than 1.0 accounted for a higher percentage of the total variance, clarified factor structure, provided more useful information for administration decision-making, and supported the view that a 1.0 eigenvalue step criterion is unnecessarily restrictive in certain situations.

INTRODUCTION

Previous studies of student ratings of courses and instructors have established the value of applying factor analysis to obtain a reduced set of evaluation dimensions (e.g., Bendig, 1954; Spencer and Aleamoni, 1969; Brooks and Tarver, 1971). The emphasis in these studies has been on identifying a minimal set of factors which represent a general set of dimensions in student ratings. But when considered from the viewpoint of the evaluative needs of instructors and administrators in specific academic areas this generalized approach may not be adequate.

Previous factor analytic studies of student ratings have normally yielded small sets of factors based on a stop factoring criterion having eigenvalues greater than 1.0 (Kaiser, 1960; Harman, 1960). Other criterion have been suggested such as Cattell's (1966) "scree test" and Horn's (1965) method which uses Guttman's latent-root-one lower bound estimate as a psychometric upper bound. Horst (1965, 1968) has suggested the alternative of determining the number of factors based on the percentage of total variance extracted where this percentage is determined with respect to a criteria such as instrument reliability.

The rationale here is that true variance is being factored. This latter alternative provides a method for obtaining a larger set of factors for explanatory purposes. For evaluation needs in specific academic areas more often the greater sin is to take out too few factors than too many. Too few factors has the effect of distorting

the factor structure--so that in terms of interpreting factors the greater error occurs in the too-few situation. Taking .70 to .75 as a reasonable estimate of the reliability of student rating forms this study posed the question of whether the stop-factoring criterion of 75% of the total variance provided a set of factors with a greater explanatory power than a set obtained by a stop criteria of an eigenvalue of one.

The purpose of this study was to determine: 1) In comparing the two approaches, does a 70-75% of the total variance stop criterion yield additional factors which are mathematically distinct and psychologically interpretable? 2) Will additional factors clarify ambiguous items, identify clusters with excessively redundant items and indicate small clusters needing additional items? 3) Is a larger set of distinctly interpretable factors more useful for evaluation of courses and instructors? 4) Does the higher stop-criterion provide more useful information for form revisions?

DATA SOURCES AND ANALYSIS METHODS

The student ratings of courses and instructors used as data for these analyses were obtained on the University of Texas at Austin College of Engineering Course-Instructor Survey Form (Appendix A). Thirty-five (items 5-39) of a total of forty-six items were included. The remaining items were excluded because they contained either categorical information or less relevant content. Each item was scored on a five-point rating scale which was coded: 1 - excellent, 2 - above average, 3 - average, 4 - below average, and 5 - unsatisfactory.

Ratings were obtained from 3,772 students in approximately 200 College of Engineering courses during the fall semester of 1971. Graduate and undergraduate courses taught by all levels of instructors were included although the classes included only those instructors who voluntarily agreed to participate in the survey. The survey forms were administered by students during one of the last regularly scheduled class meetings. The instructor was asked to leave the room while the students ananymously completed the survey form.

Using individual responses as a data base (as opposed to class means), the ratings were intercorrelated and subjected to two principal components, unit diagonals, factor analyses. A varimax rotation was then performed on the principal components factors (Kaiser, 1959). These analyses were performed on the 6600 computer system at the UT Austin Computation Center using program FACTOR (Veldman, 1967). A missing data option was utilized which allowed means, standard deviations and correlation coefficients between pairs of items to be based only on the ratings of students who responded to those items or pairs of items. The first analysis was performed using standard stop-factoring criterion of obtaining only those factors whose eigenvalues are greater than one. The second analysis used a stop-criterion of 75% of the total variance. The first analysis yielded five factors and the second analysis resulted in ten factors.

RESULTS

The results obtained from using a stop-criterion of 70-75% of the total variance as opposed to an eigenvalue of 1.0 can be compared for 1) percent of total variance accounted for, 2) mathematical

stability, 3) factor clarity and distinctiveness, 4) redundancy (excessive items in a factor, 5) meaningful interpretability and 6) utility of results for administrative decision-making. The factor solutions can also be examined to determine implications for form revision.

As indicated in Table 1 the percent of trace or total variance accounted for by the proportion of variance stop-criterion is 74.88% while the eigenvalue 1.0 stop-criterion yielded factors accounting for 64.55% of the total variance. Thus a difference of 10% more variance is accounted for th the larger set of factors.

Table 2 describes the relationship of the five factor set to the new factors emerging in the ten factor set. For example factor 5 in the five factor set splits into factors 5,7 and 8 in the ten factor set. These relationships are not exact in that single items from other factors may be involved as will be seen later (Table 6) but Table 1 does serve the purpose of showing how the interpretability of factors is is increased by the larger set of factors. For example it would be difficult to interpret the combination of factors 5,7 and 8 which emerged from the original factor 5 by one interpretive name. It would have to combine effect on student, course content and course assignments. A close examination of the individual items listed in Table 3 for each factor of the ten factor set will reveal that each new factor clarifies the interpretability of the factor structure.

As may be seen in Table 2 two factors (3 and 4) remained stable while the other three factors (1,2 and 5) yielded five additional factors. All five of the new factors were meaningfully interpretable.

Tables 4 and 5 show the primary factor loadings (highest loading of an item) on the rotated factor solutions of the five and ten factor solutions respectively. If the mathematical distinctiveness of a

TABLE 1

EIGENVALUES & PERCENTAGES OF TRACE

Solution	Factor	Eigenvalue	% Of Trace	
			Unrotated	Rotated
One	1	16.75	47.84	17.14
-	2	1.85	5.29	17.44
E-value	3	1.60	4.58	5.30
of	4	1.27	3.63	11.67
1.0	5	1.12	3.21	12.98
			64.55	64.53
Two	1	16.75	47.84	10.35
-	2	1.85	5.29	14.37
75%	3	1.60	4.58	5.01
of	4	1.27	3.63	11.52
Var.	5	1.12	3.21	8.96
	6	.88	2.52	7.79
	7	.75	2.14	4.25
	8	.69	1.98	4.60
	9	.65	1.86	4.76
	10	.64	1.83	3.27
			74.88	74.88

TABLE 2

FACTOR RELATIONSHIPS

5 Factor Set	10 Factor Set
Factor 1	1. Instructor openness 6. Instructor interest in students
Factor 2	2. Instructor organization & clarity 9. Instructor speaking & writing 10. Course application (one item)
Factor 3	3. Course grading
Factor 4	4. Instructor enthusiasm
Factor 5	5. Effects on students 7. Course content 8. Course assignments

TABLE 3

FACTOR-ITEM GROUPINGS

TEN FACTOR SOLUTION

Factor I: Instructor Openness

18. He encourages class discussion.

21. He invites criticism of his own ideas.

35. He is sensitive tc the responses of the class, encourages student participation, and welcomes questions and discussion.

Factor II: Instructor Organization & Clarity

14. He presents the subject matter in an organized, easily understood fashion.

34. He makes himself clear, states objectives, summarizes major points, presents material in an organized manner and provides emphasis.

12. The instructor explains the material clearly.

13. He identifies what he considers to be the important concepts in the course.

11. The instructor makes clear to the students what the educational objectives of the course are.

22. He usually knows whether or not the class is understanding him.

33. The instructor has command of the subject, presents material in an analytic way, contrasts points of view, discusses current developments, and relates topics to other areas of knowledge.

26. He answers student questions effectively in class.

23. He keeps well informed about the progress of the class.

Factor III: Course Grading

39. Homework is usually graded and returned promptly.

38. The grader for this course is accessible and helpful.

Factor IV: Instructor Enthusiasm

30. He seems to have self-confidence.

29. He seems to enjoy teaching this course.

28. He is a dynamic and energetic person.

37. He enjoys teaching, is enthusiastic about his subject, makes the course exciting, and has self-confidence.

16. He inspires confidence in his knowledge of the field of this course.

Factor V: Effect on Students

32. I have developed an increased appreciation for this subject after taking this course.

8. In comparison with other Engineering courses I have taken at UT Austin, this course has been:

31. He has enhanced my skills in thinking and in problem solving.

19. He has motivated me to do my best possible work in this course.

Factor VI: Instructor Interest in Students

25. He is available to students outside of class.

36. He is available to and friendly toward students, is interested in students as individuals, is himself respected as a person and is valued for advice not directly related to the course.

24. He seems to have a genuine interest in students.

27. He appears to be fair and impartial in his contacts with students.

Factor VII: Course Content

6. The textbook in this course is a good one.

5. The content of this course is professionally up-to-date.

Factor VIII: Course Assignments

17. His assignments and his expectations on homework are clear.

20. He has obtained sufficient evidence to evaluate accurately my achievement in this course.

7. The homework assignments support and enhance the learning experience in this course.

Factor IX: Instructor Speaking & Writing

10. He writes on the chalkboard legibly and large enough to be seen clearly.

9. The instructor speaks clearly and can be easily understood.

Factor X: Course Application

15. He relates course material to engineering applications by giving appropriate examples and illustrations.

TABLE 4

PRIMARY* FACTOR ~~SOLUTION~~ LOADINGS ON

ROTATED FIVE FACTOR SOLUTION

1		2		3		4		5	
item	loading	item	loading	item	loading	item	loading	item	loading
18	.72	14	.73	39	.87	30	.75	32	-.70
21	.72	34	.72	38	.84	29	.71	8	-.68
35	.72	12	.71			28	.67	31	-.68
36	.72	13	.68			37	.65	19	-.64
24	.67	11	.67			16	.55	5	-.61
25	.64	9	.62			(33)	.50	6	-.55
27	.61	10	.60					7	-.54
(26)	.53	17	.49					20	-.50
23	.53	15	.463						
22	.52	26**	.48						
		33**	.464						

*Primary loading = highest loading of an item

**non-distinctive loading = item having a non-primary loading greater then lowest primary loading for that factor.

◯ = primary loading of an item having a non-distinctive loading on another item.

TABLE 5

PRIMARY FACTOR LOADINGS

ON ROTATED TEN FACTOR SOLUTION

1 item-loading	2	3	4	5	6	7	8	9	10
18 .77	14 .72	39 .87	30 .79	32 -.75	25 .83	6 .86	17 -.63	10 -.77	15 .61
21 .73	34 .70	38 .85	29 .73	8 -.64	36 .63	5 .50	20 -.57	9 -.63	5** .47
35 .67	12 .70		28 .72	31 -.63	24 .61		7 -.47		
22** .54	13 .64		37 .66	19 -.57	27 .55				
(26 .44)	11 .55		16 .54						
	22 .55		(33 .42)						
	33 .51								
	23 .46								
	26 .45								
	15* .46								

*non-distinctive loading (re Table 4)

**non-primary loadings which are greater than lowest primary loading on any factor, i.e., greater than item 26 in factor 2.

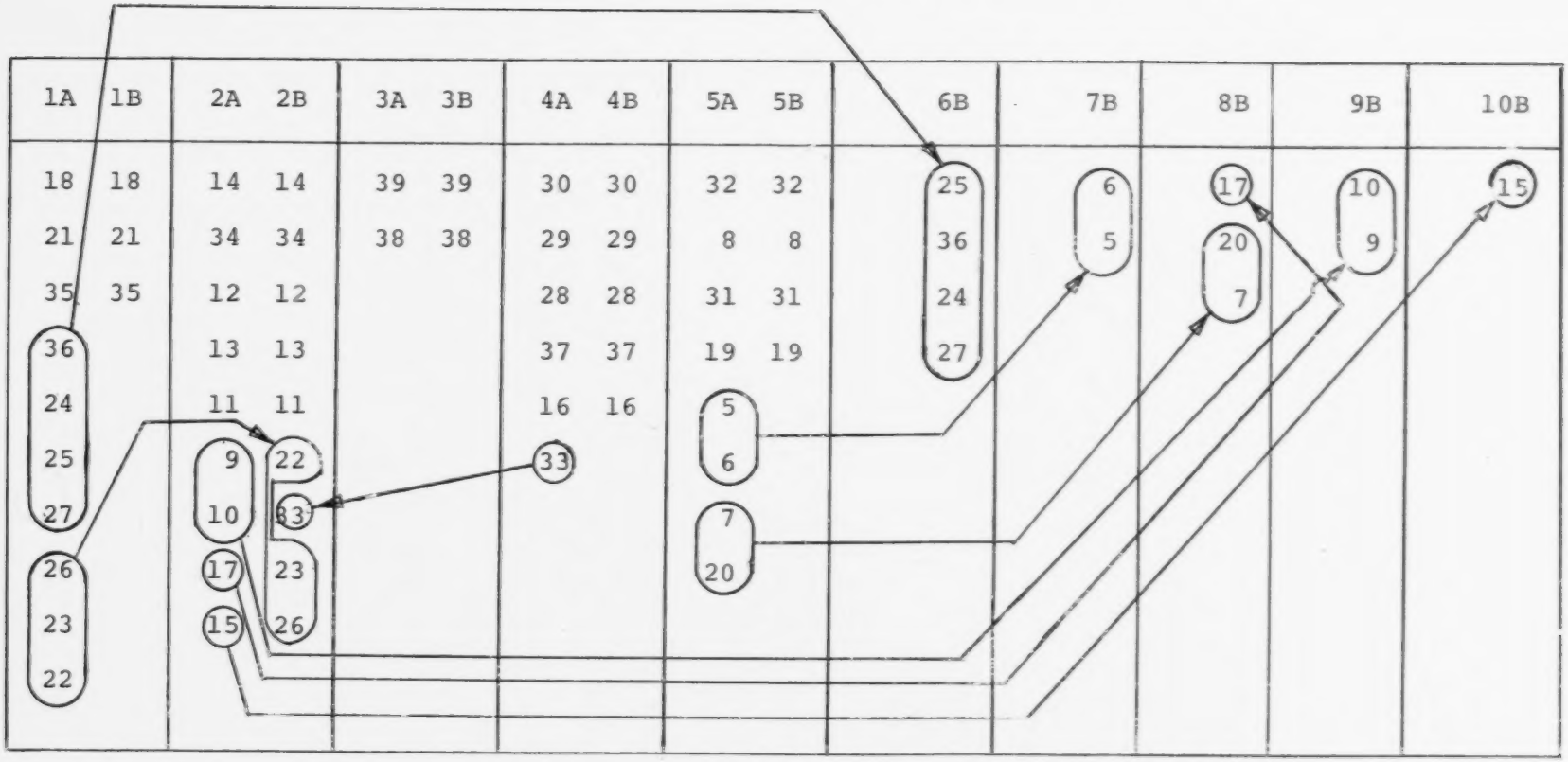
factor is defined as the absence in a factor of any item with a non-primary loading greater than the lowest primary loading for that factor, then it can be seen in Table 5 that four of the five new factors are mathematically distinct. Although the non-distinct factor (10) is a one item split-off from factor 2 (where it continues to have a non-distinct loading), it is meaningfully interpretable from the original factor.

An item which has a non-distinctive loading (i.e. a non-primary loading greater than the lowest primary loading for that factor) is an ambiguous item. In Table 4 it is seen that the five factor solution contains two ambiguous items - item 26 and item 33. In Table 5 it can be seen that the ambiguity of these items is eliminated although one new ambiguity emerges (item 15 which becomes factor 10). Overall the ambiguity of items appears to be reduced by the larger set though not conclusively.

Table 6 diagrams the movement of primary loadings of items between the two factor sets. The stability of factors 3 and 4 is clearly seen in that factor 3 remains identically the same and factor 4 loses only one item. The clarification of factors 1 and 5 is also clearly seen in the forming of three distinctively new factors. Just in terms of item movement factor 2 does not appear to be improved although, as previously indicated, the new cluster of items is more easily interpreted. Concerning item redundancy it can be noted in Table 6 that only one factor (2) in the ten factor set remained with greater than 7 items while three factors (1,2 & 5) originally contained greater than 7 items in the five factor set. With the exception then of one factor, redundancy was greatly improved. Table 6 also shows the need for additional items in factors 3,7, 9 and 10 of the larger set.

TABLE 6

CHANGES IN ROTATED FACTOR LOADINGS



A - Five factor solution

B - Ten factor solution

CONCLUSIONS AND SIGNIFICANCE

From the results of this study the following conclusions can be made: 1) The stop-criterion of 75% of the total variance yielded factors covering a higher percentage of the total variance. The distinctiveness and interpretability of the factors added considerably to the interpretive clarity of the survey. 2) The clarification of factors provided by the larger set of factors proved more useful for evaluation purposes than a smaller more general set of factors. 3) Useful information was obtained for revising the form both with respect to ambiguous and redundant items and to distinctive clusters needing additional items. 4) Follow-up studies with data bases in the same college curriculum area and in other curriculum areas are needed to determine the stability of these findings, to determine the nature of factor results when all faculty members participate in the survey and to determine the comparability of results when class averages rather than individual student responses are factored.

The significance of the study lies in providing supporting evidence for the value of considering the use of a factoring procedure based on a 70-75% stop-criterion for course-instructor survey studies. From the viewpoint of providing information to administrators and instructors, the use of a stop-criterion of eigenvalue 1.0 is seen as unnecessarily restrictive. Course-instructor survey studies may more appropriately be geared toward a factor methodology that provides more situation-specific factors. The study calls attention to the difference in results that can be obtained by the use of two different factor extraction criteria. Work in the field has seen "blind" adoption of the eigenvalue 1.0 criterion with little consdieration for the purpose

of factor studies. From the viewpoint of determining general laws of behavior, the eigenvalue 1.0 criterion with individual student responses seems appropriate. Conversely, the "applications" viewpoint argues for the more "liberalized" cirterion based on the estimated reliability of the rating instrument. This approach yields more specific factors that are valuable to administrators and instructors as they make decisions about the content of courses and the quality of instruction. From the theoretical point of view as well, the factor methodology has been biased toward eigenvalue 1.0 interpretations. Thus, this study is seen as having, possibly, important theoretical ramifications as well.

REFERENCES

Bendig, A. W. A factor analysis of student ratings of psychology instructors in the Purdue Scale Journal of Educational Psychology, 1954, 45, 385-393.

Brooks, T. E. and Tarver, D. A. A factor study of student ratings of courses and instructors at The University of Texas at Austin. Paper presented at the Annual Meeting of the National Council on Measurement in Education. New York City, February, 1971.

Cattell, R. G. The scree test for the number of factors. Multivariate Behavioral Research, 1966, 1 245-276.

Harman, H. H. Modern Factor Analysis. Chicago; The University of Chicago Press, 1960.

Horn, J. L. A rationale and test for the number of factors in factor analysis. Psychometrika, 30, 2, 179-185.

Horst, P. Factor Analysis of Data Matrices. New York: Holt, Rinehart and Winston, Inc., 1965.

Horst, P. Personality: Measurement of Dimensions. San Francisco: Josey-Bass, Inc., 1968.

Spencer, R. E. and Aleamoni, L. M. The Illinois Course Evaluation Questionnaire: A description of its development and a report of some of its results. Measurement and Research Division, Office of Instructional Resources, University of Illinois, 1969.

Veldman, D. J. Fortran Programming for the Behavioral Sciences. New York: Holt, Rinehart and Winston, 1967.

ADDITIONAL REFERENCES

Kaiser, h. F. Computer program for varimax rotation in factor analysis. Educational and Psychological Measurement, 1959, 19, 413-420.

Kaiser, H. F. Comments on communalities and the numbers of factors. Read at an informal conference, "The Communality Problem in Factor Analysis," St. Louis: Washington University, 1960 (dittoed) Referenced in Cooley, W. W. and Lohnes, P. R. Multivariate Data Analysis. New York: John Wiley & Sons, 1971.

THE UNIVERSITY OF TEXAS AT AUSTIN COURSE/INSTRUCTOR SURVEY COLLEGE OF ENGINEERING

INSTRUCTIONS: PLEASE MARK YOUR RESPONSES TO EACH ITEM ON THE SEPARATE ANSWER SHEET

Please devote some time and thought to completing this Questionnaire, and respond to the items as honestly and fairly as you can. Most instructors do study the results of the Questionnaires, and many will make an honest effort to improve course materials or their own classroom performance if they get a clear indication that improvement is needed in some area.

Do not sign your name to any of the forms. Use a Number 2 pencil to darken the appropriate rectangle for each item and press down hard enough to blacken the rectangle on the original and on all carbon copies. Do not use ink or a ball point pen, as the scanning machine which processes the answer sheet will not read ink.

Do not mark responses to items which are not relevant to this course.

GENERAL:

1. My classification is: A = Graduate B = Senior C = Junior D = Sophomore E = Freshman
2. My final grade in this course will probably be: A = A B = B C = C D = D E = F
3. My over-all grade-point average at UT Austin is: A = 3.50 - 4.00 B = 2.75 - 3.49 C = 2.00 - 2.74
   D = Less than 2.00 E = I have received no grades as yet
4. The school or college in which I am enrolled is: A = Arts and Sciences B = Business Administration
   C = Architecture D = Engineering E = Other

Items 8 - 39 all use the same response scale, in which:

A = Excellent
B = Above average
C = Average
D = Below average
E = Unsatisfactory

COURSE EVALUATION:

5. The content of this course is professionally up to date.
6. The textbook in this course is a good one.
7. The homework assignments support and enhance the learning experience in this course.
8. In comparison with other Engineering courses I have taken at UT Austin, this course has been:

INSTRUCTOR EVALUATION:

9. The instructor speaks clearly and can be easily understood.
10. He writes on the chalkboard legibly and large enough to be seen clearly.
11. The instructor makes clear to the students what the educational objectives of the course are.
12. The instructor explains the material clearly.
13. He identifies what he considers to be the important concepts in the course.
14. He presents the subject matter in an organized, easily understood fashion.
15. He relates course material to engineering applications by giving appropriate examples and illustrations.
16. He inspires confidence in his knowledge of the field of this course.
17. His assignments and his expectations on homework are clear.
18. He encourages class discussion.
19. He has motivated me to do my best possible work in this course.
20. He has obtained sufficient evidence to evaluate accurately my achievement in this course.
21. He invites criticism of his own ideas.
22. He usually knows whether or not the class is understanding him.
23. He keeps well informed about the progress of the class.
24. He seems to have a genuine interest in students.

25. He is available to students outside of class.

26. He answers student questions effectively in class.

27. He appears to be fair and impartial in his contacts with students.

28. He is a dynamic and energetic person.

29. He seems to enjoy teaching this course.

30. He seem to have self-confidence.

31. He has enhanced my skills in thinking and in problem solving.

32. I have developed an increased appreciation for this subject after taking this course.

OVER-ALL EVALUATION OF INSTRUCTOR

33. The instructor has command of the subject, presents material in an analytic way, contrasts points of view, discusses current developments, and relates topics to other areas of knowledge.

34. He makes himself clear, states objectives, summarizes major points, present material in an organized manner and provides emphasis.

35. He is sensitive to the responses of the class, encourages student participation, and welcomes questions and discussion.

36. He is available to and friendly toward students, is interested in students as individuals, is himself respected as a person and is valued for advice not directly related to the course.

37. He enjoys teaching, is enthusiastic about his subject, makes the course exciting, and has self-confidence.

GRADER EVALUATION

38. The grader for this course is accessible and helpful.

39. Homework is usually graded and returned promptly.

ADDITIONAL ITEMS

For items 40-46, choose the appropriate response from those given for the item.

40. The number of quizzes given during the course is:

A = Too large B = About right C = Too small

41. The quizzes are generally:

A = Too difficult B = About right in difficulty C = Too easy

42. The quizzes are generally:

A = Too long B = About right in length C = Too short

43. The pre-requisities for this course are:

A = Not sufficient; there should be more
B = Very appropriate
C = Adequate
D = More than are needed; there should be fewer
F = Non-existent; there are none, and none are needed

44. For each hour of class, the average amount of time I spend on this course outside of class is about:

A = 4 hours or more
B = 3 hours
C = 2 hours
D = 1 hour
E = Less than 1 hour

45. The amount of content of this course is:

A = Too extensive to cover in one semester
B = About right for one semester
C = Not extensive enough to require a whole semester

46. The classroom in which this course meets is:

A = Good
B = Adequate
C = Needs improvement (In the COMMENTS section of the answer sheet, please state how it should be improved.)